Accessing the Ideas Cloud

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Harvard Business School
Harvard - NASA Tournament Laboratory

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This Work Cites Research Done in Collaboration with:

- Kevin Boudreau (London Business School)
- Lars Bo Jeppesen (Copenhagen Business School)
- Andrew King (Tuck School of Business at Dartmouth)
- Nicola Lacetera (University of Toronto)
- Eric von Hippel (MIT Sloan School of Management)
- Bob Wolf

Solving the Toughest Scientific Problem from 300 Years Ago

British Fleet Sinks in 1707
Due to Bad Navigation

Solving the Toughest Scientific Problem from 300 Years Ago

The Longitude Prize
1714 - Up to £20,000
Any one can enter
Need a working solution

Solving the Toughest Scientific Problem from 300 Years Ago

Sir Isaac Newton – Principle Advisor to the Longitude Board:

"And I have told you oftener then once that it [the longitude] is not to be found by Clock-work alone.....Nothing but Astronomy is sufficient for this purpose (the only right method and the method pointed at by the Act of Parliament). I am unwilling to meddle with any other methods then the right one.

Solving the Toughest Scientific Problem from 300 Years Ago

Local Search to Longitude Problem

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Solving the Toughest Scientific Problem from 300 Years Ago

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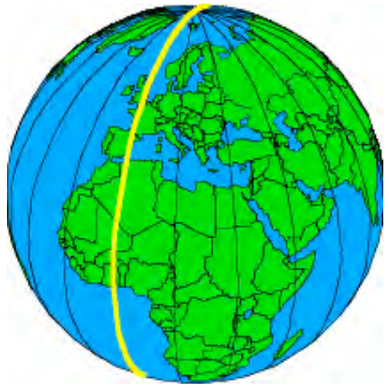
Over 100 Solutions Proposed

Solving the Toughest Scientific Problem from 300 Years Ago

Local Search to Longitude Problem



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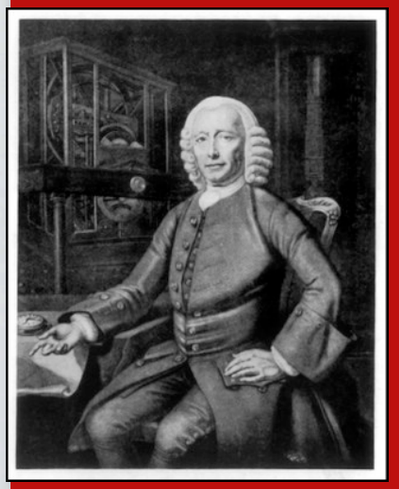


Chronometer Wins
John Harrison
Unknown
Cabinet Maker

Agenda

- Two Key Innovation Concepts
- How to Organize the Cloud
- Motivations
- Diversity and Knowledge Access
- Searching for Extreme Values

Joy's Law Haunts Innovation Efforts

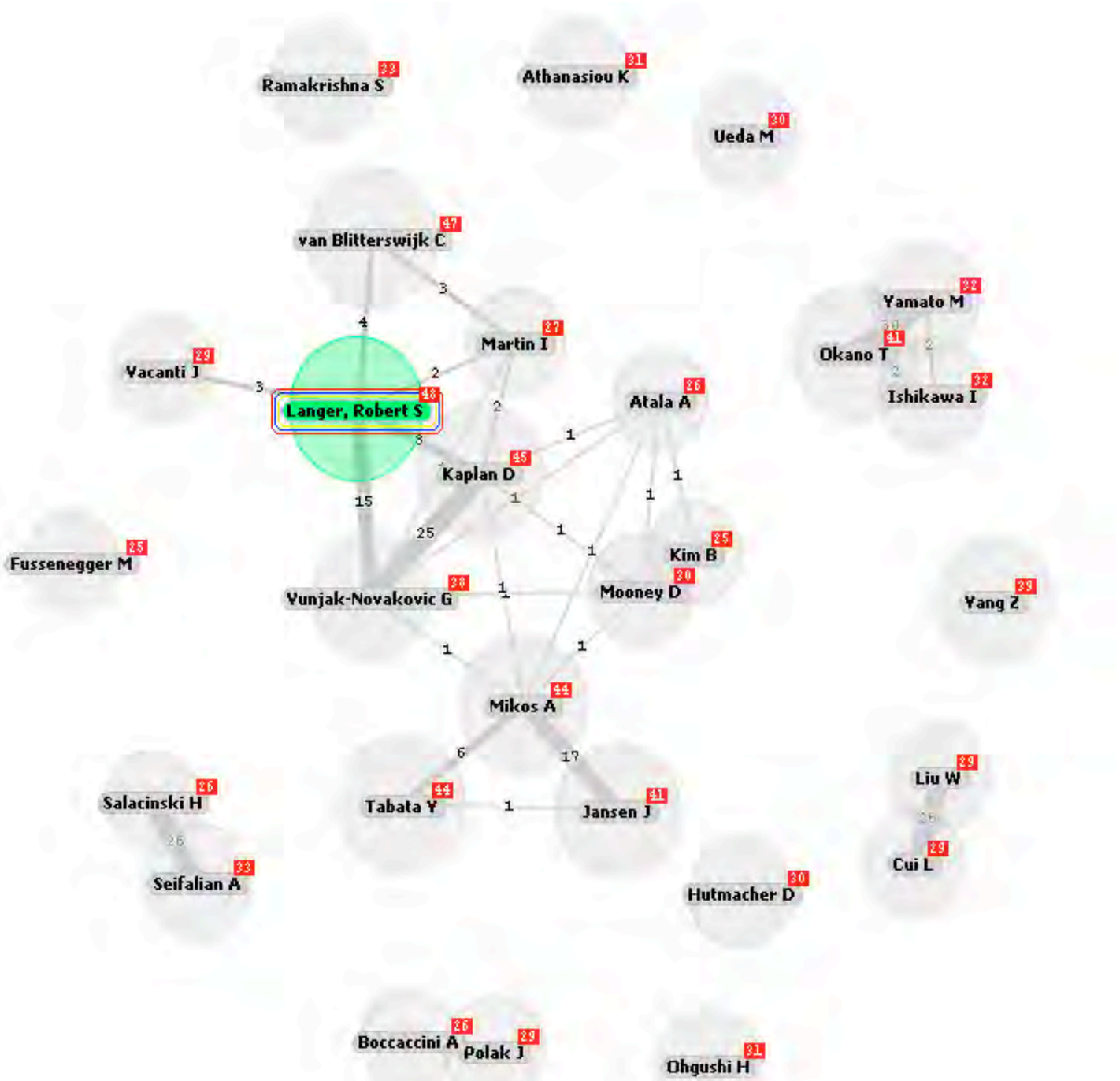
"No Matter Who You Are, Most of the Smartest People Work for Someone Else"

Bill Joy, Cofounder Sun Microsystems

Professor Bob Langer from MIT is Co-Founder of Tissue Engineering Field

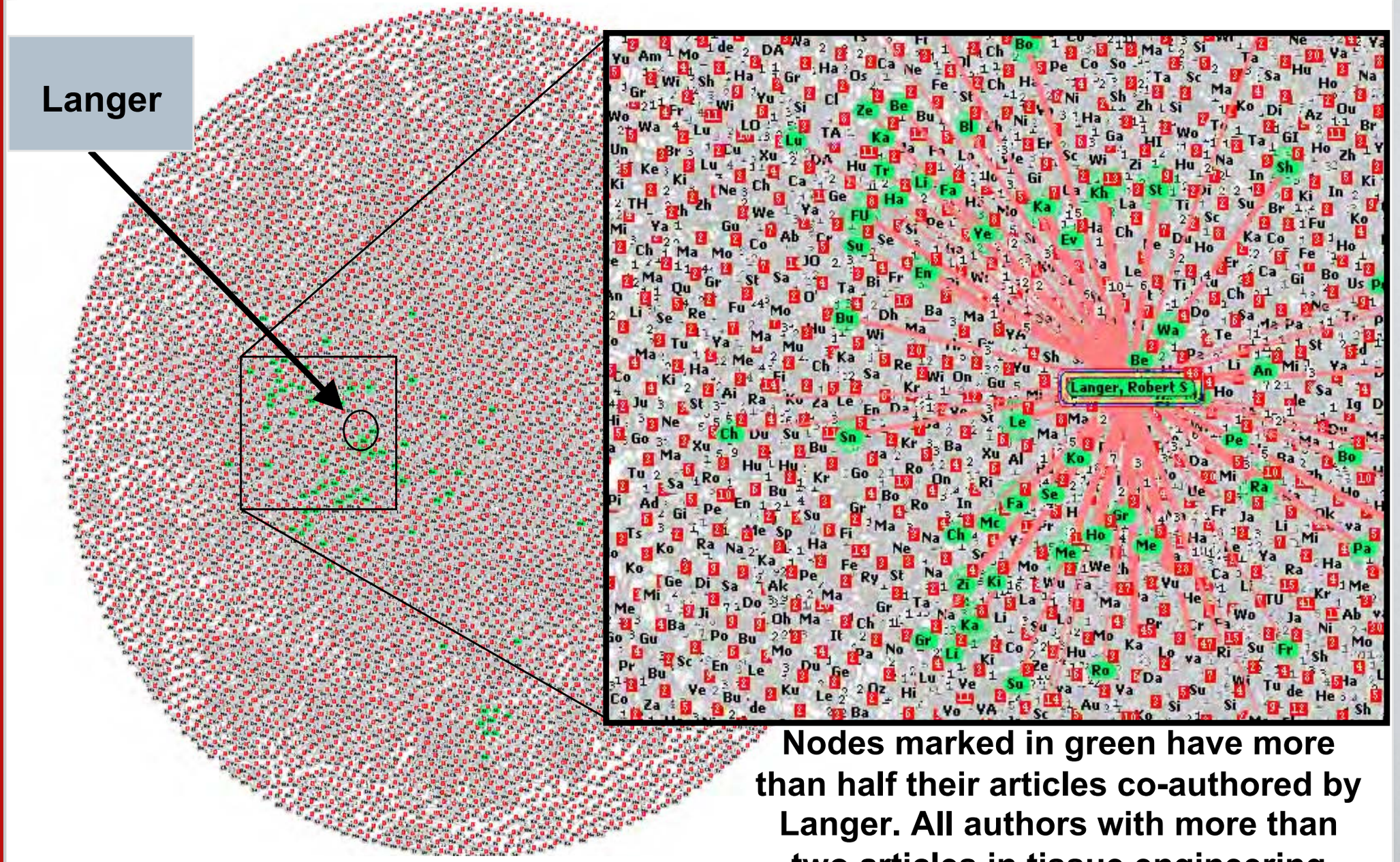
- MIT Institute Professor (one of 12)
- Over 600 patents
- Over 1000 scientific papers
- Largest biomedical engineering lab with over 100 researchers
- Youngest person to be elected to National Academy of Sciences, National Academy of Engineering and Institute of Medicine

Langer Collaborates with ~40% of Prolific Authors in Tissue Engineering (> 25 Publications) 2004 - 2006



Source: BCG Analysis

Joy's Law in Tissue Engineering 6131 Articles by 17,044 Authors 2004-2006



Nodes marked in green have more than half their articles co-authored by Langer. All authors with more than two articles in tissue engineering between 2004-2006 are showing

Note: Network map of all authors that have published two or more articles on tissue engineering between 2004 and 2006. A total of 17044 authors published 6131 articles.
Source: Pubmed database, BCG analysis

The Causal Explanation for Joy's Law

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- Knowledge is unevenly distributed in society - Fredrich von Hayek (1945)

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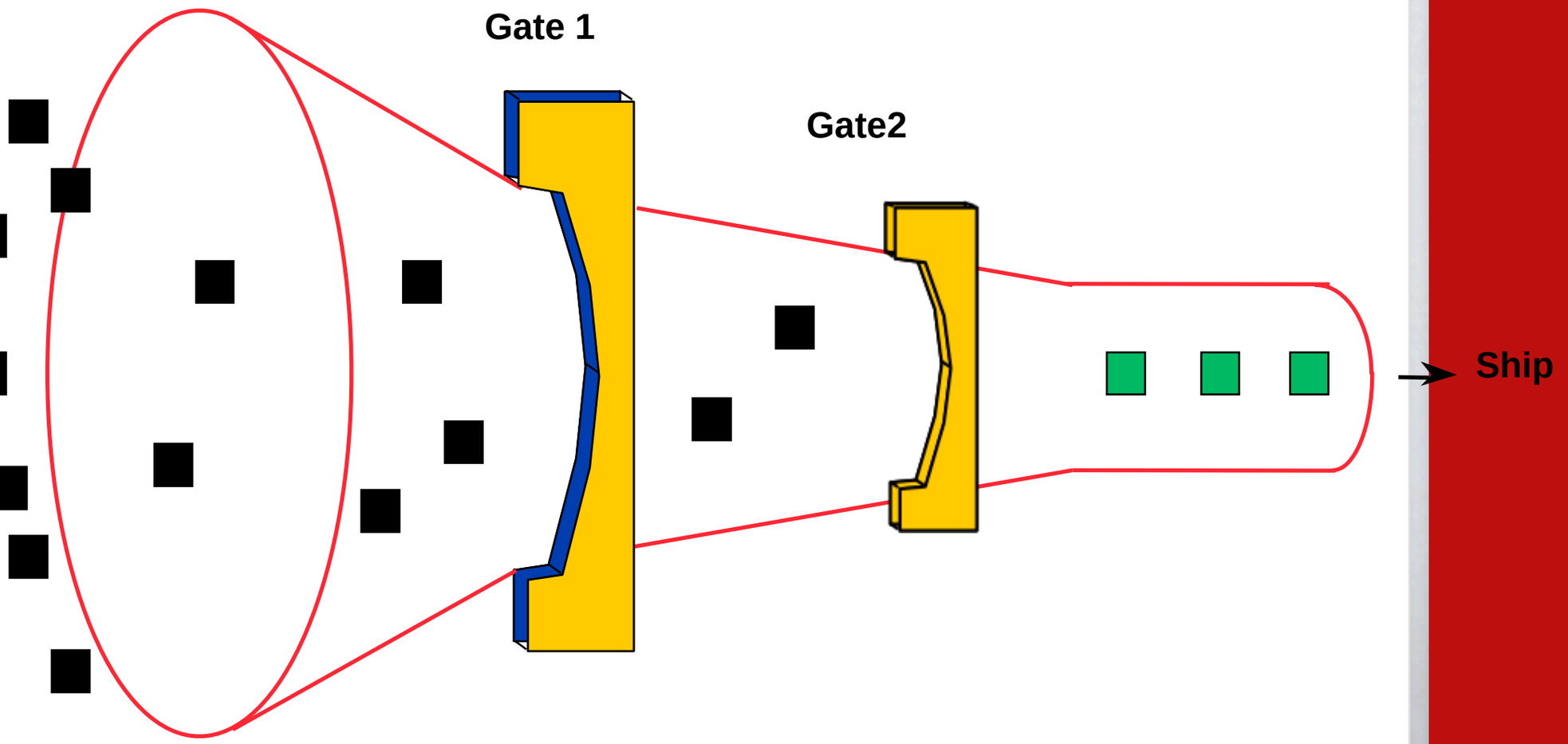
The Causal Explanation for Joy's Law

- Knowledge is unevenly distributed in society - Fredrich von Hayek (1945)
- Knowledge is sticky - Eric von Hippel (1994)

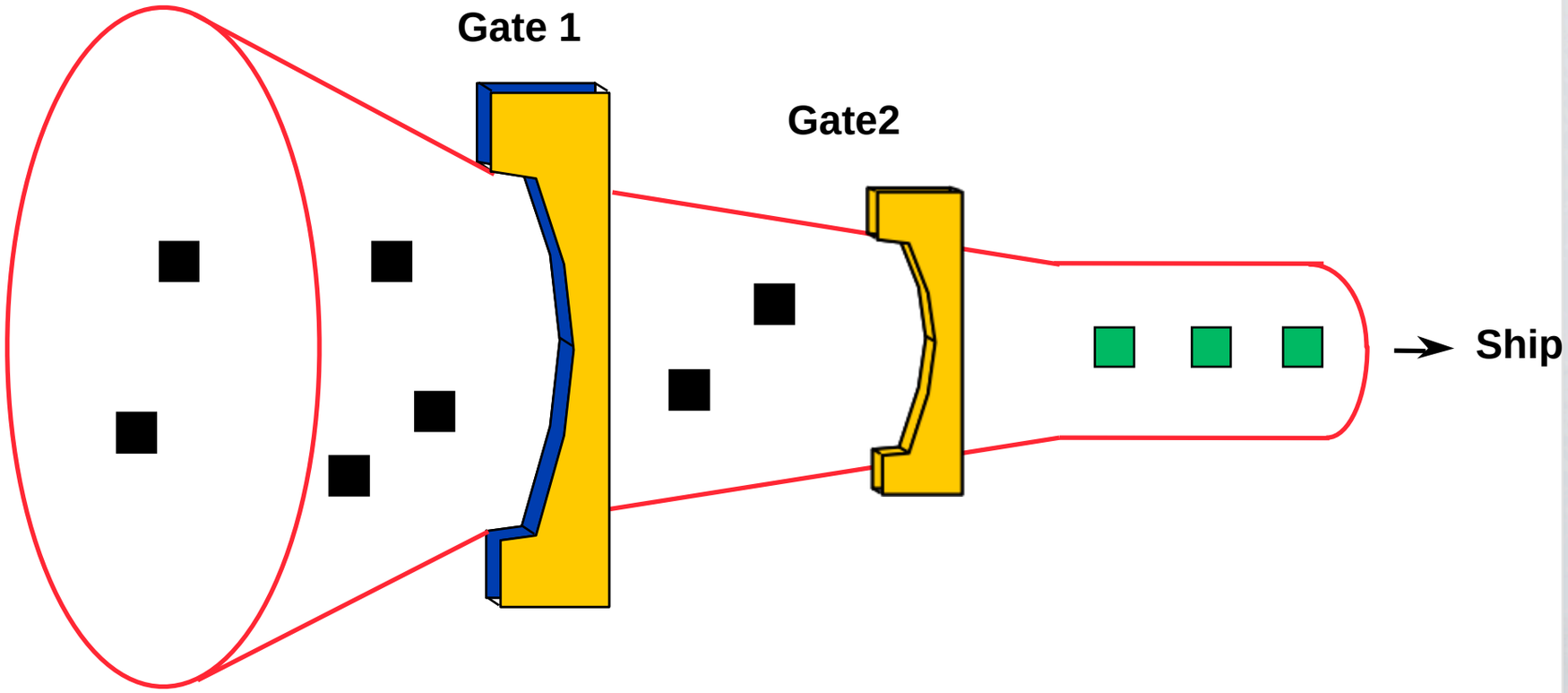
Managing the Ideas Funnel is Key to Innovation

Generate | Select | Generate | Select | **Implementation**

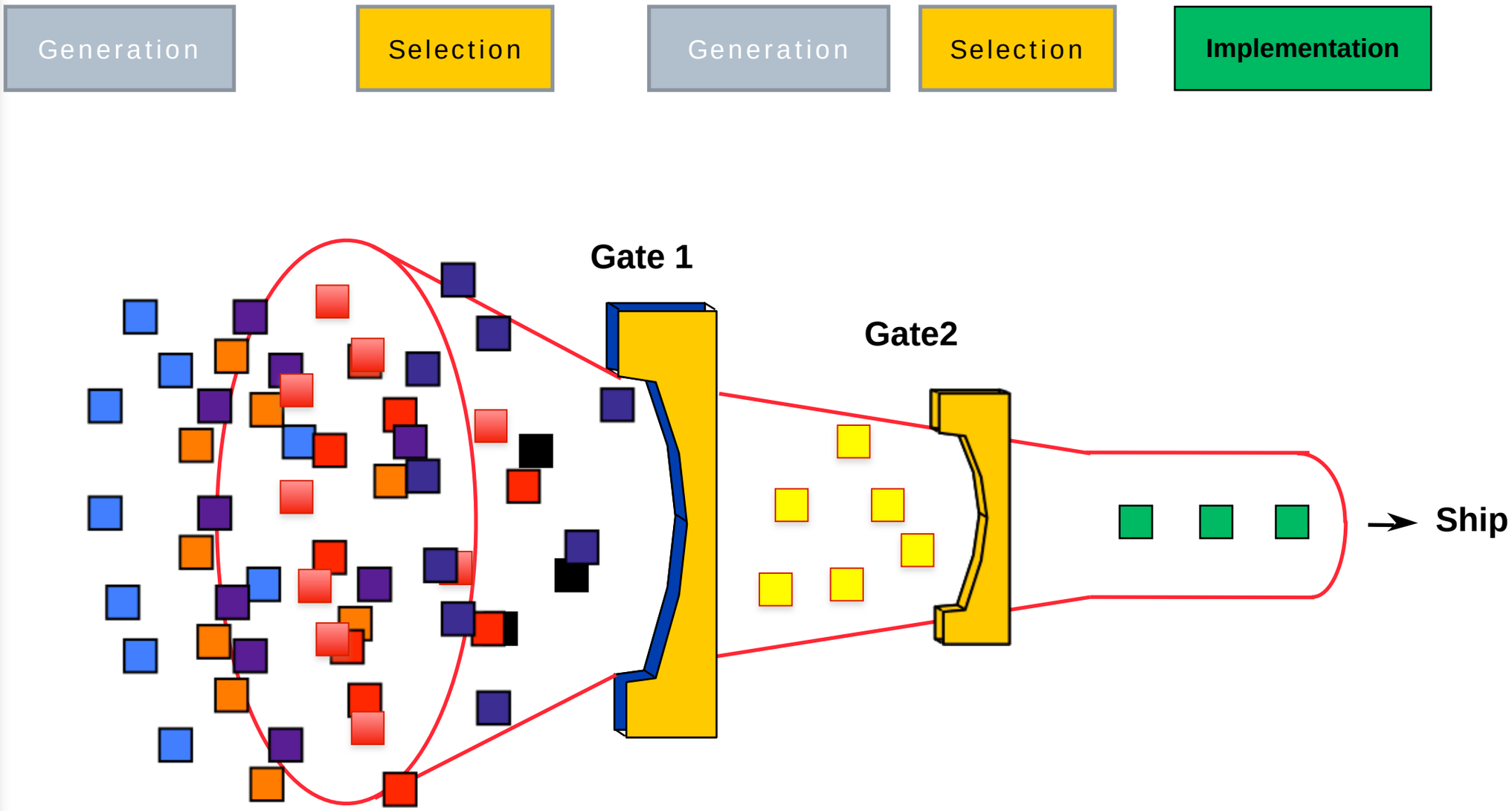


Most Innovation Efforts Suffer From Lack of Initial Variety and Number of Approaches

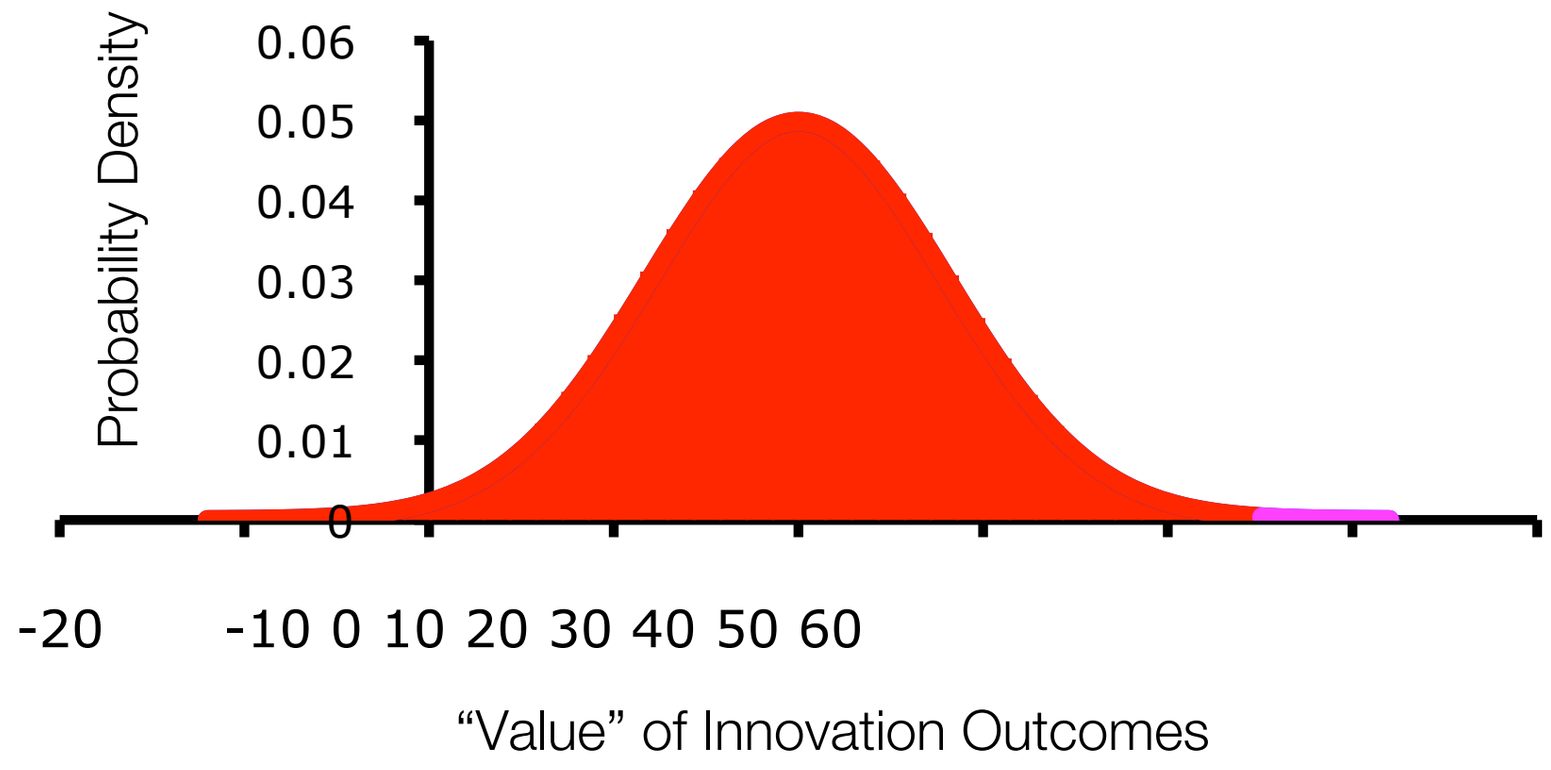
Generation | Selection | Generation | Selection | **Implementation**

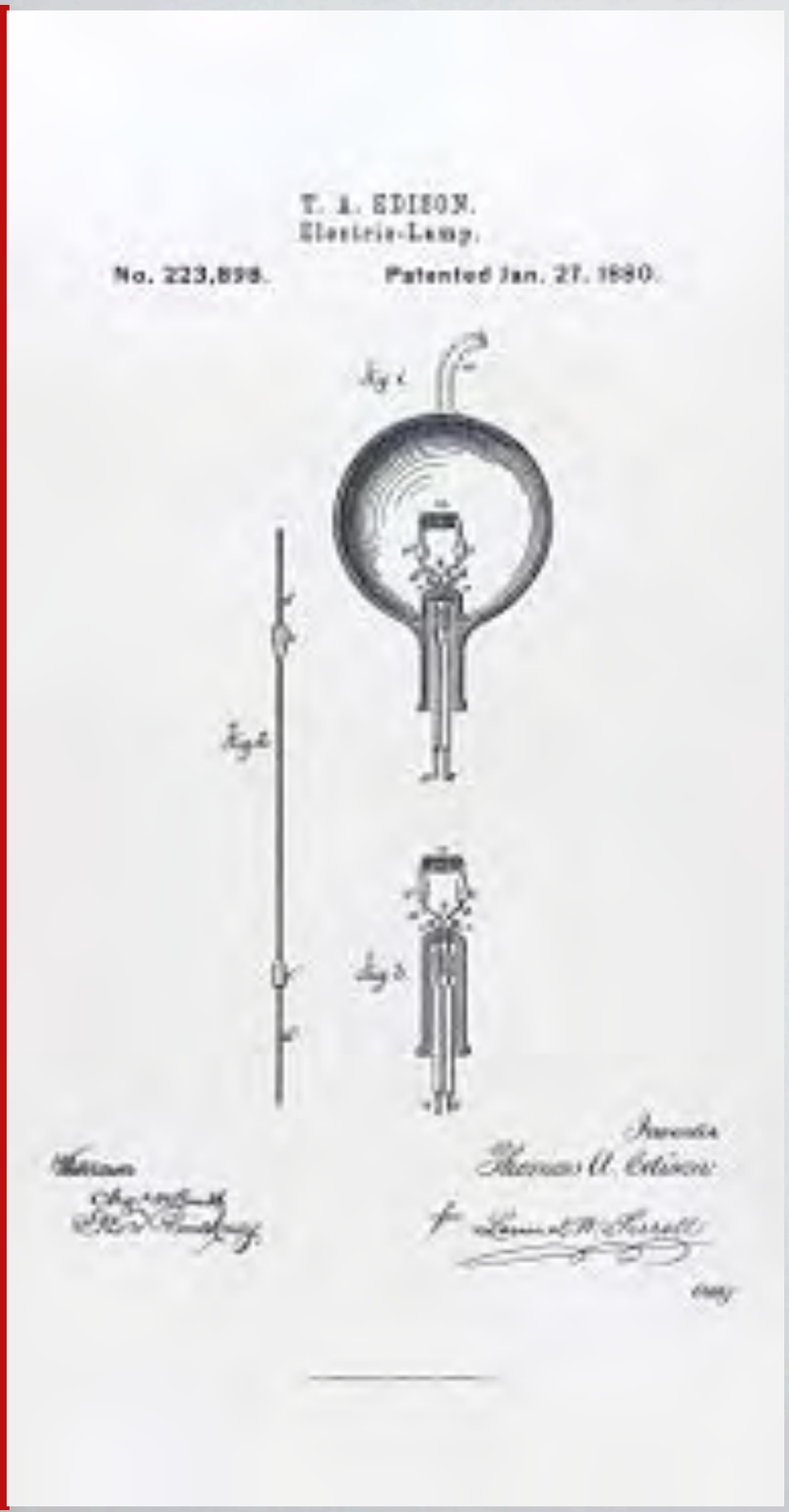


Quantity and Variety of Ideas Critical to Innovation Success



Accessing “Extreme Value” Outcomes Critical to Innovation




T. A. EDISON.
Electric-Lamp.
No. 223,898. Patented Jan. 27, 1880.
Fig. 1.
Fig. 2.
Fig. 3.
Witnesses
Inventor
Thomas A. Edison
per Lemuel W. Serrell
atty

Reflections from Edison

"Before I got through," he recalled, "I tested no fewer than 6,000 vegetable growths, and ransacked the world for the most suitable filament material."

"Genius is one percent inspiration and ninety-nine percent perspiration.“

“*I didn’t fail. I just* discovered 9999 *ways NOT* to invent the *light bulb*.”

Distributed Innovation Can Help to Increase Idea Variety and Volume Through Competitions or Collaborations

Competition

- Innovation problem requires diversity of approaches
- Contributions tend to be substitutes
- Arms-length, rules based contracts
- External innovators are competitive
- Driven by extrinsic motivations and profits

Collaboration

- Innovation problem requires cumulative knowledge building
- Contributions range from mix&match to co-production
- Informal, norms-based governance
- External innovators are cooperative
- Driven by intrinsic and extrinsic motivations

Many Firms Are Accessing the Ideas Cloud

COMPETITIVE MARKETS	■ Apple Inc. iPhone (application store) ■ InnoCentive.com (scientific problem solving) ■ Local Motors Inc. (car design) ■ Ryz (shoes) ■ TopCoder Inc. (software code)	■ Cloud computing initiatives (Amazon.com Inc. and Google) ■ Gore-Tex ■ Personal computer platforms and hardware "OEMs" ■ Google Android (hardware development)	■ SAP (third-party applications) ■ Facebook Inc. (advertisers and widget developers) ■ Most Web portals, yellow pages ■ eBay Inc., Craigslist Inc. ■ Big Idea Group (innovation hunts) ■ Video games on consoles
COLLABORATIVE COMMUNITIES	■ Threadless.com (T-shirts) ■ Google Android (software development of operating system)	■ Video game "modders" (such as Valve Corp.'s Half-Life platform) ■ Linux and open-source development (such as TiVo Inc. and Motorola Inc.'s use of Linux) ■ Medical device companies and physicians (user innovators) ■ Wikipedia	■ Apple Inc. iPhone ("jail breakers") ■ Big Idea Group (insight clubs) ■ Communispace Corp. (product feedback and innovation communities) ■ SAP (developer network) ■ Statacorp Lp (statistical software module development)

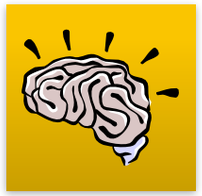
Motivations to Participate

Why should we care?

High creativity

What motivates?

Fun, skill, freedom and need



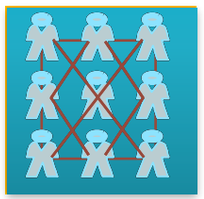
Increasing knowledge biggest benefit

Who are these guys?

Volunteer time

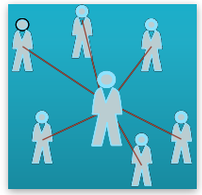
Professionals

What about the community?



Strong identification

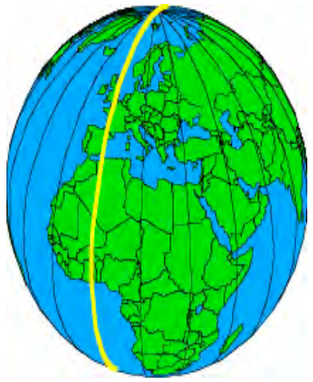
Global effort



Peer leadership preferred

Innovation Tournaments are Historically Important & Currently Popular

The Duomo - Florence
1418 - Up to 2,000 Florins



The Longitude Prize
1714 - Up to £20,000

Invention of Food Canning
1800 - Up to 12,000 Francs

Ansari X-Prize – Space Travel
1996 – $10,000,000

INNOCENTIVE
WHERE THE WORLD INNOVATES

Scientific Problem Solving
2001 – Average $30,000

Local Motors – Car Design
2008 – Over 35000 Submits

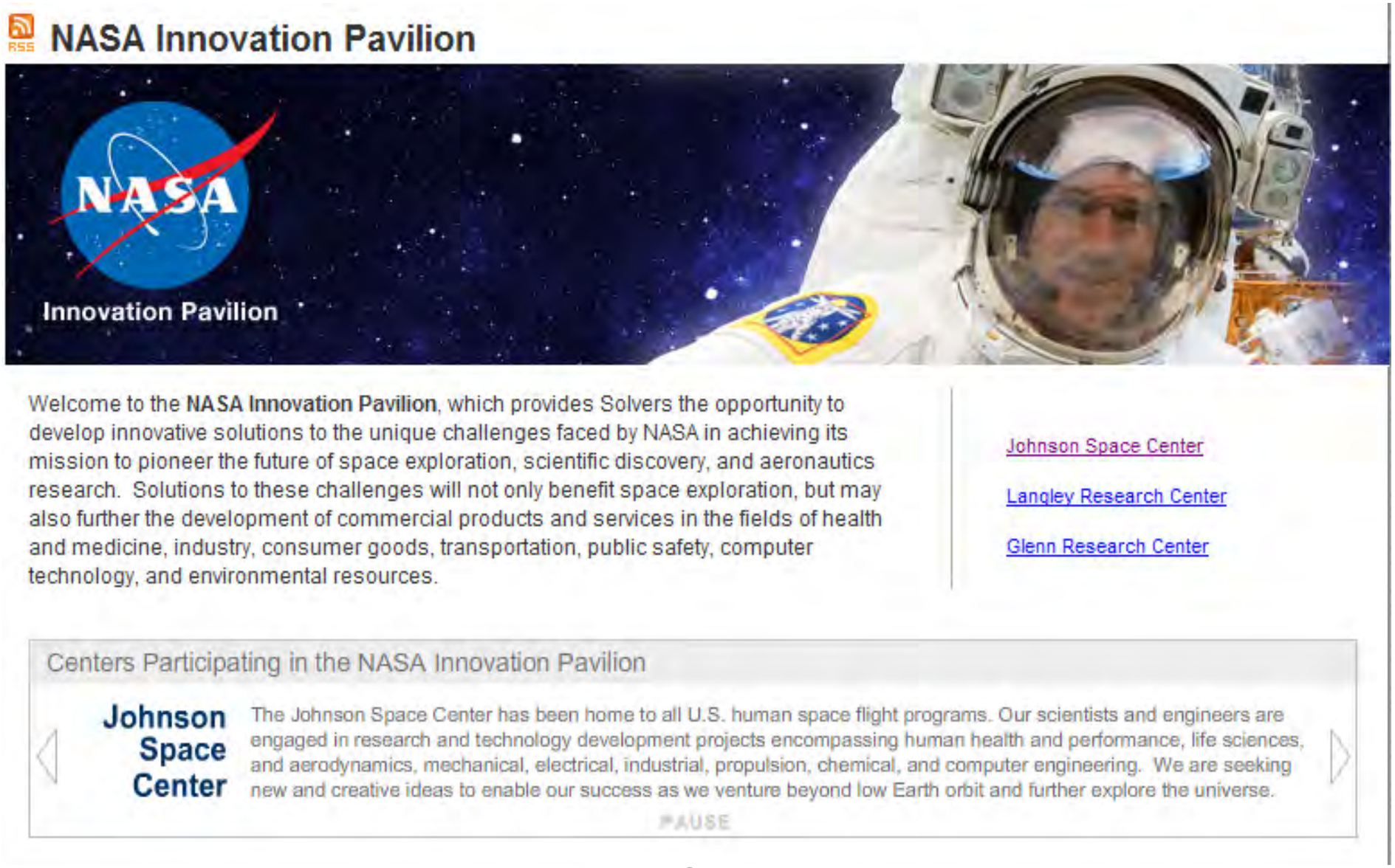
InnoCentive as a Modern Implementation of Innovation Contests

R&D Labs | Knowledge Broker | >225, 000 independent scien

Context:

1. R&D Labs inside of major multinationals are not able to solve certain scientific problems
   - Their own internal and external experts cannot obtain solutions
2. Hope to get solution by going to distributed scientists that they do not know who may have an answer

NASA Pavilion on InnoCentive



2900 Solvers – 80 countries

InnoCentive Pilot:
Challenge Data and Statistics

Challenge Title	Ctr	Posted	Deadline	Proj Rms	Sub	Award Date	Award Amount
Improved Barrier Layers... Keeping Food Fresh in Space	**JSC - SLSD**	**2/28/2010**	**2/28/2010**	**174**	**22**	**5/7/2010**	**$11,000**
Mechanism for a Compact Aerobic Resistive Exercise Device	JSC - SLSD	12/18/2009	2/28/2010	564	95	5/14/2010	$20,000
Data-Driven Forecasting of Solar Events	**JSC - SLSD**	**12/22/2009**	**3/22/2010**	**579**	**11**	**5/13/2010**	**$30,000**
Coordination of Sensor Swarms for Extraterrestrial Research	LRC	2/27/2010	4/26/2010	423	37	6/4/2010	$18,000 (3)
Medical Consumables Tracking	**GRC**	**5/17/2010**	**7/27/2010**	**365**	**56**	**in progress**	**$15,000 (3)**
Augmenting the Exercise Experience	JSC - SLSD	5/27/2010	7/27/2010	229	18	9/20/2010	$10,000
Simple Microgravity Laundry System	**JSC - EA**	**5/27/2010**	**7/27/2010**	**598**	**108**	**9/21/2010**	**$7,500**

Two Central Questions

1. What explains which problems get solved?

- Heterogeneity in the scientific interests of the pool of solvers competing to win
- Specialization in the solver pool

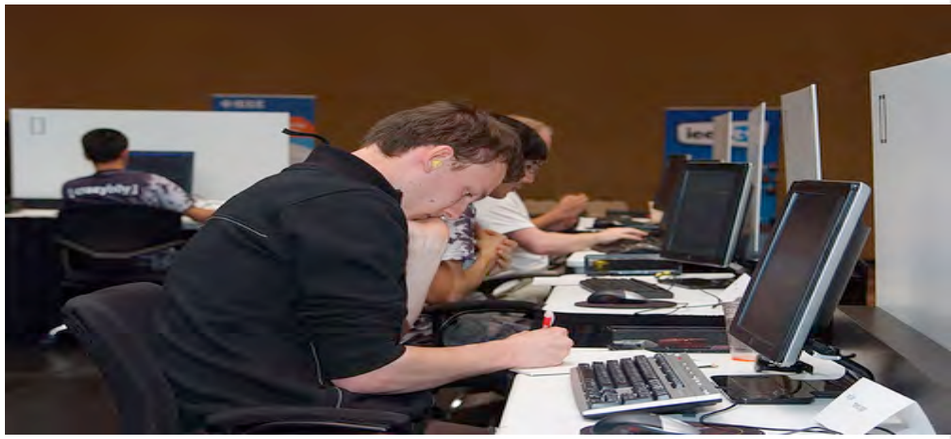
2. What explains who creates a winning solution?

- Technical Marginality: Increasing distance between solver's own field of expertise and the problem field
- Social Marginality: Women scientists, when they enter, more likely to win

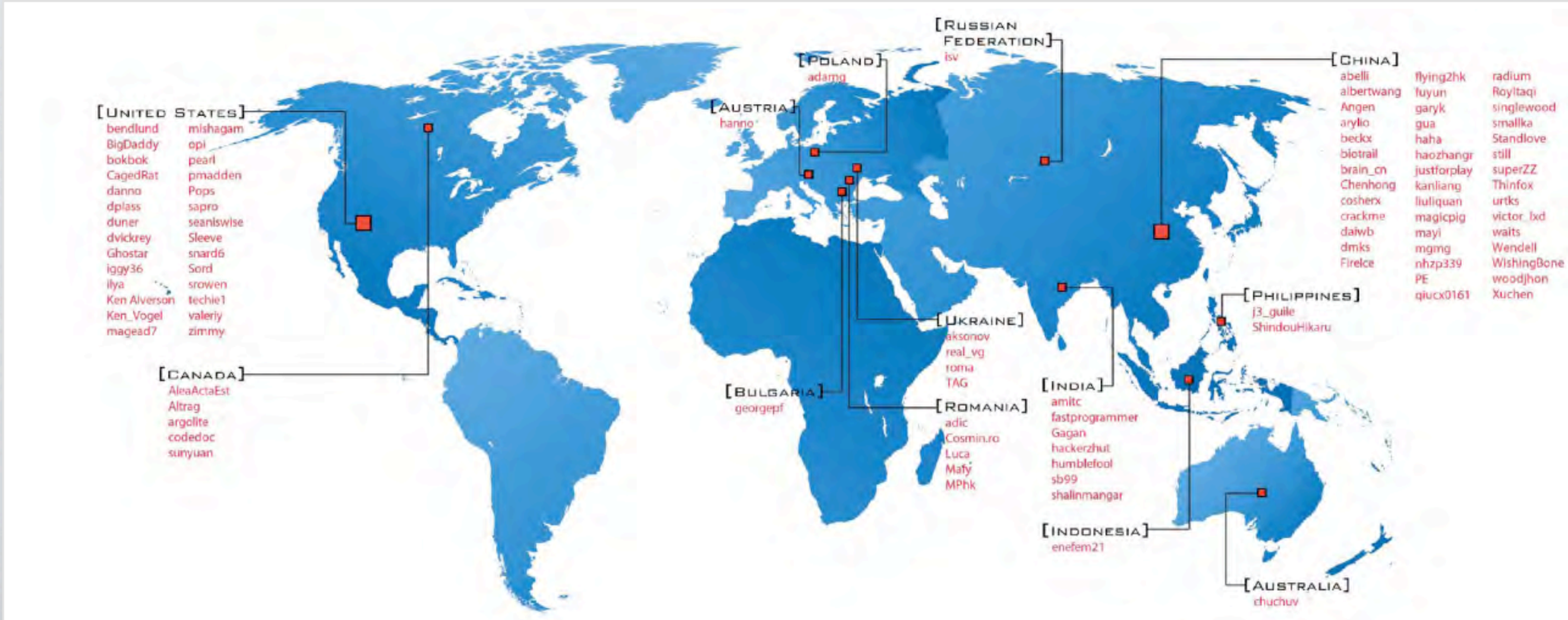
Source: Jeppesen and Lakhani***, Organization Science*** (2010)

TopCoder Builds Complex Systems Through Contests

- 2-sided marketplace:
  - Community of elite software coders (>200,000 members)
  - Global IT firms as clients
- “Virtual” Competitions:
  - Attract, reward, assess and record skill
  - Prizes up to $25,000
  - Points for creativity, correctness and speed of solution
  - Full range of software problems
  - Ex-post learning and community building



TopCoder Global Footprint



Winning Contributors to a Sample Financial Services Application

Contests Have Inherent Tradeoffs Between Incentives and “Extreme Value” Outcomes

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- Key question in contest design is about how many competitors should enter?

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- Lots of entry means lower probability of winning - less incentives to work hard

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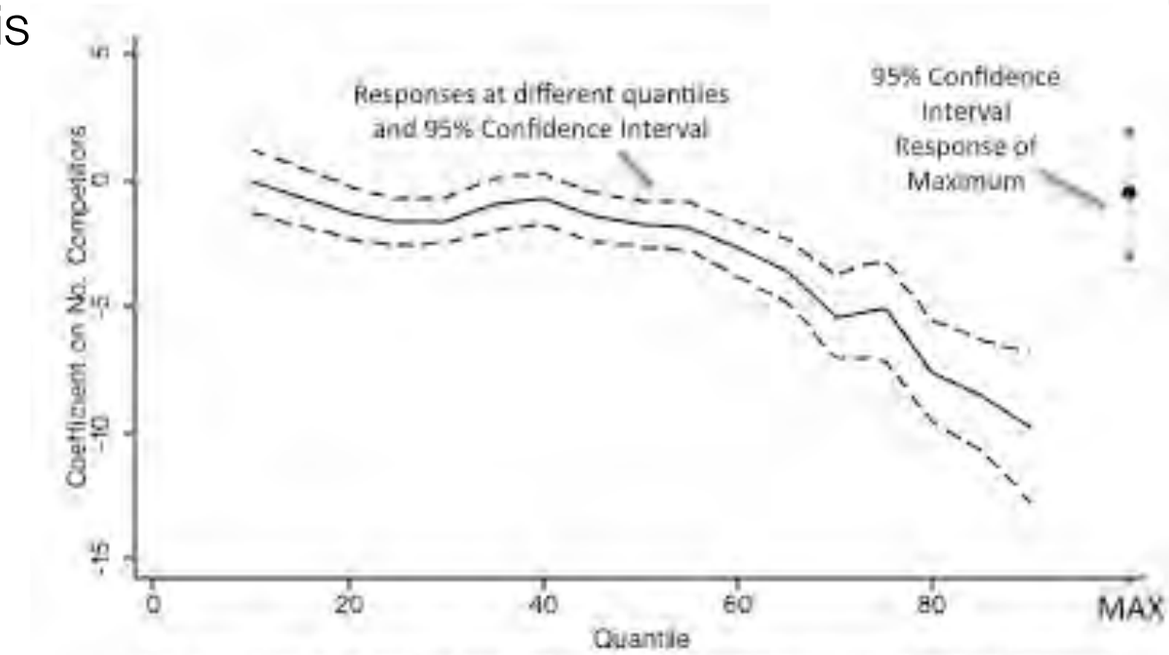
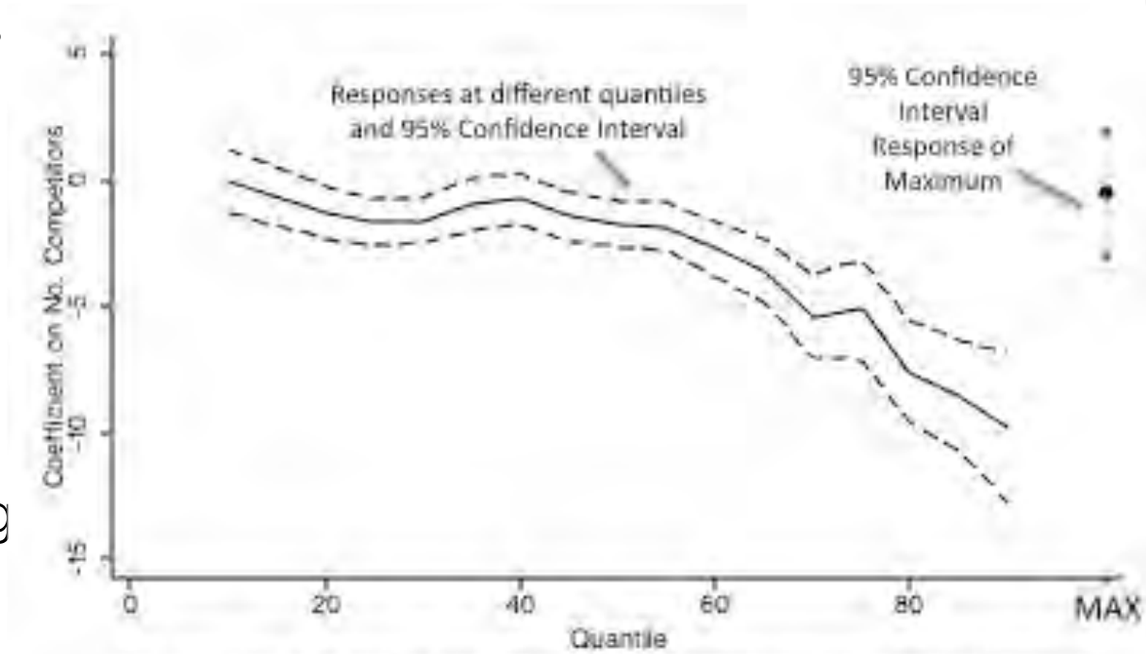


Note: Each Point on the solid line measures the relationship between performance and No. Competitors at the respective quantile, controlling for a fixed effect for the particular problem being solved and controlling for the distribution of skills of individuals within a given room. The dotted lines represent the 95% confidence interval. The response of maximum score is shown at the position of the 100% position (precisely the maximum); the dot is the coefficient estimate, with 95th percent confidence intervals shown above and below.

Contests Have Inherent Tradeoffs Between Incentives and “Extreme Value” Outcomes

- Key question in contest design is about how many competitors should enter?
- Lots of entry means lower probability of winning - less incentives to work hard
- But this could be offset by finding an outlier response as more people come on



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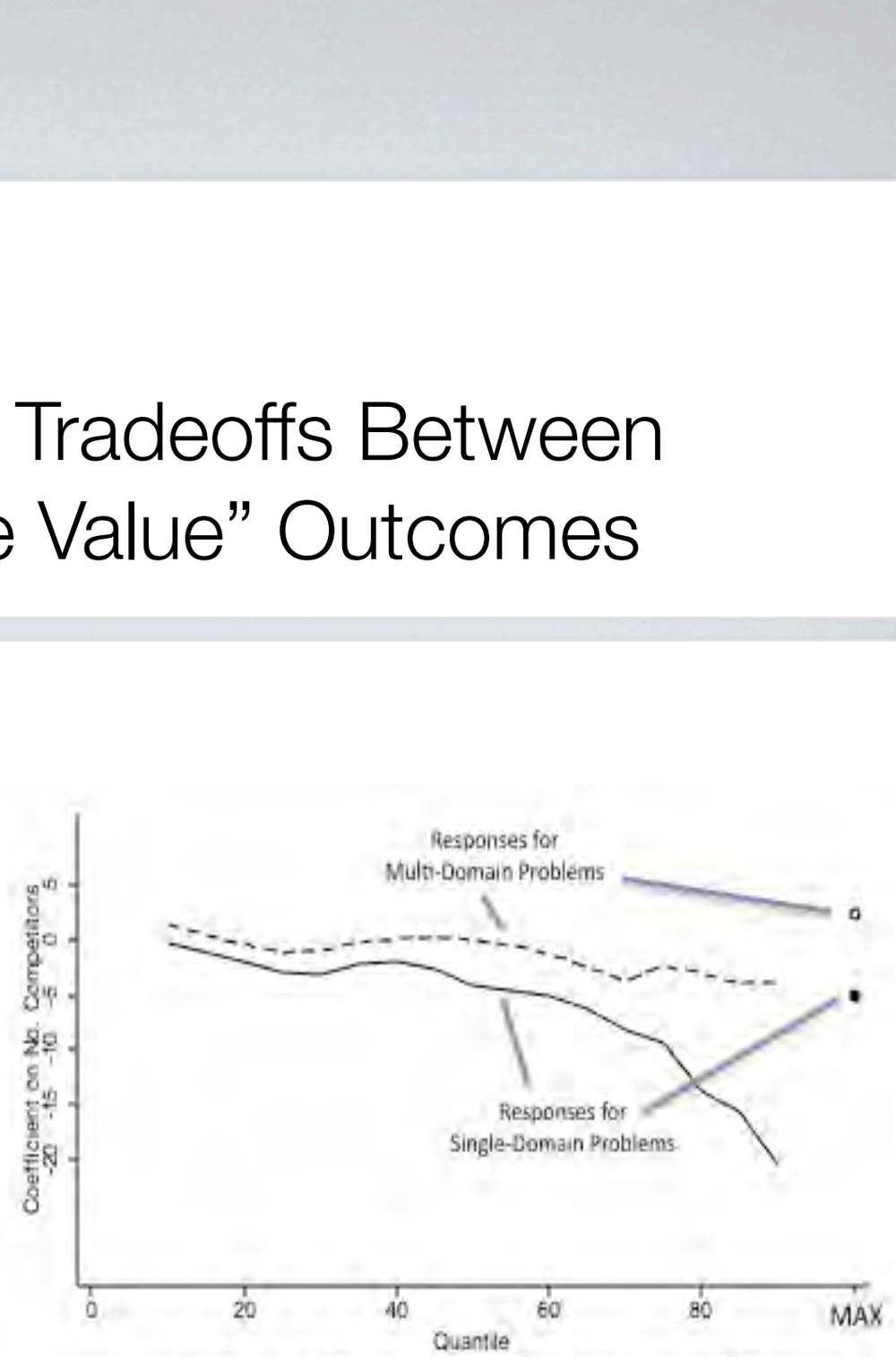

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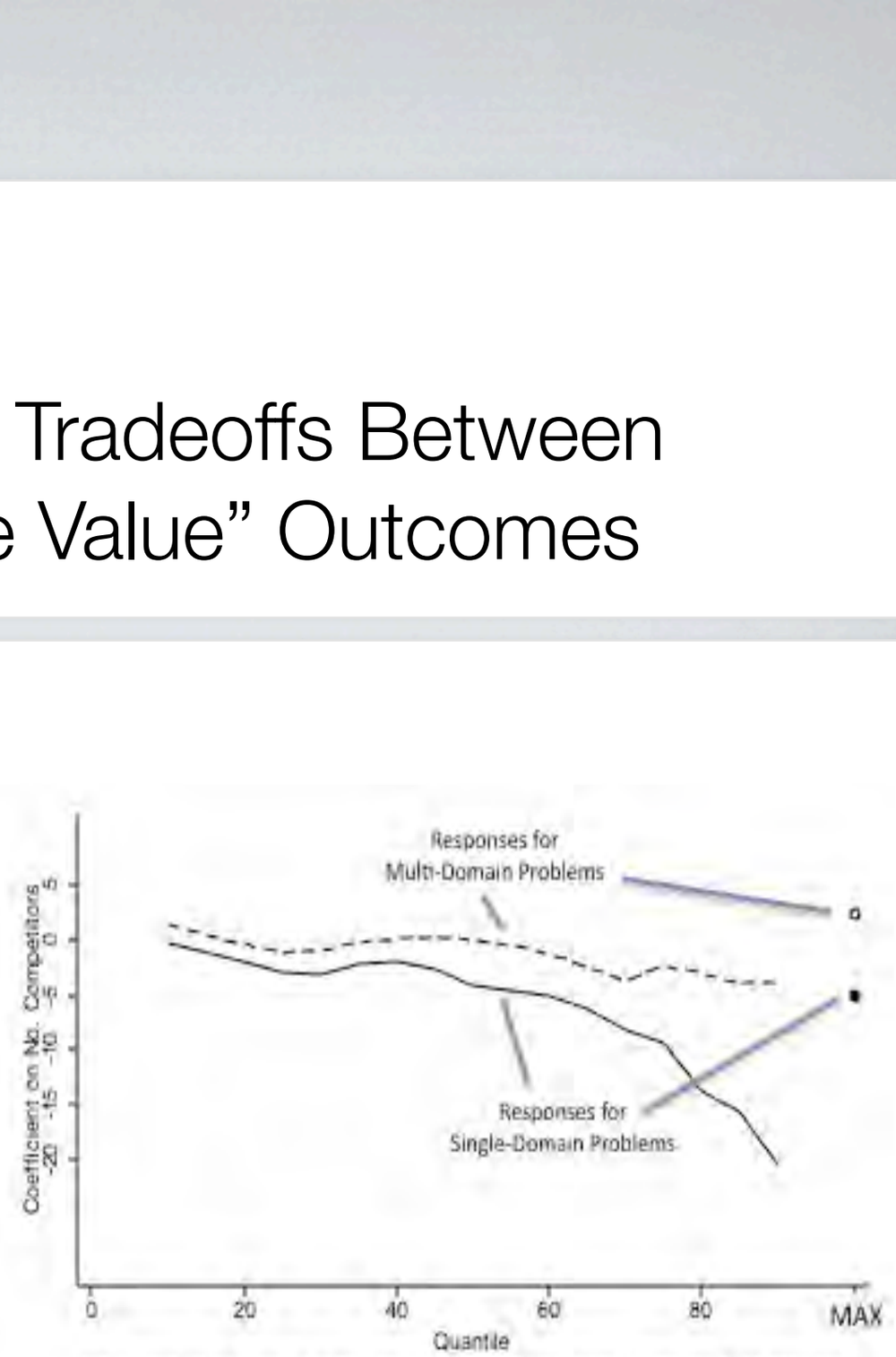
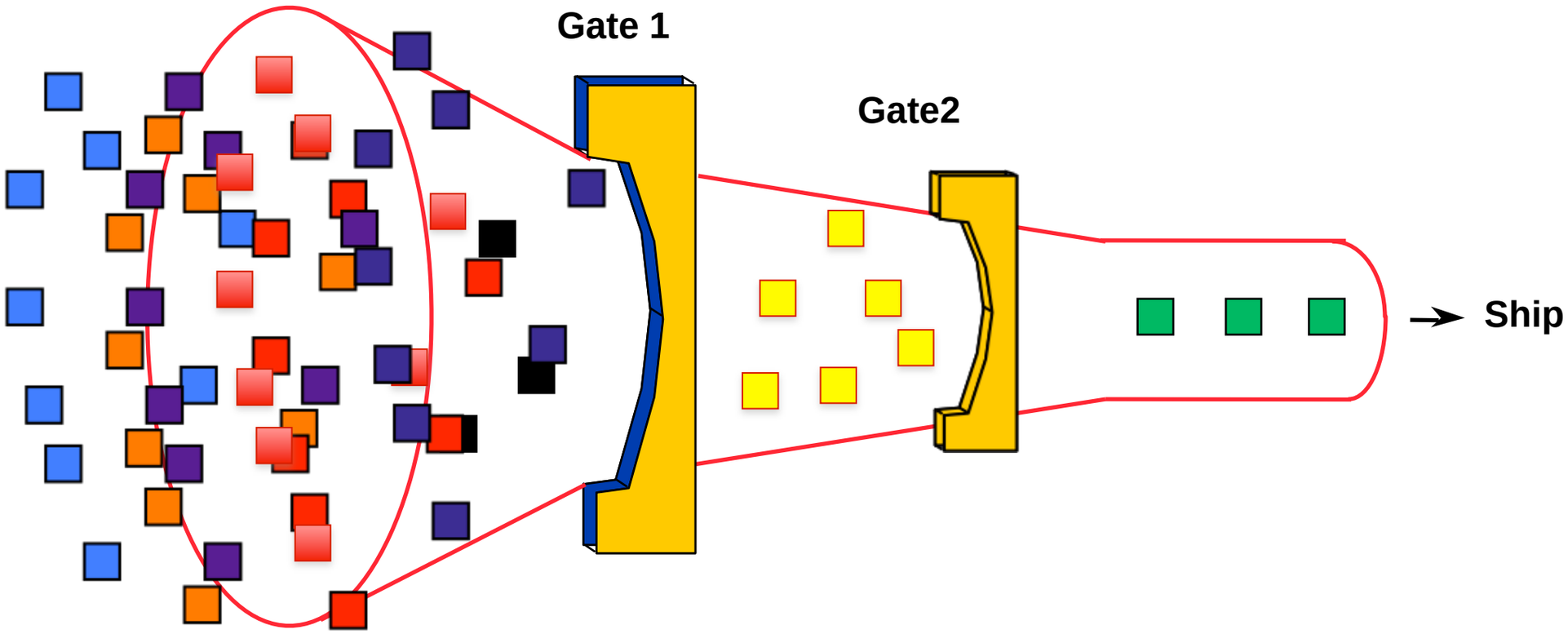
- Key question in contest design is about how many competitors should enter?
- Lots of entry means lower probability of winning - less incentives to work hard
- But this could be offset by finding an outlier response as more people come on
- Problem uncertainty can moderate outcomes

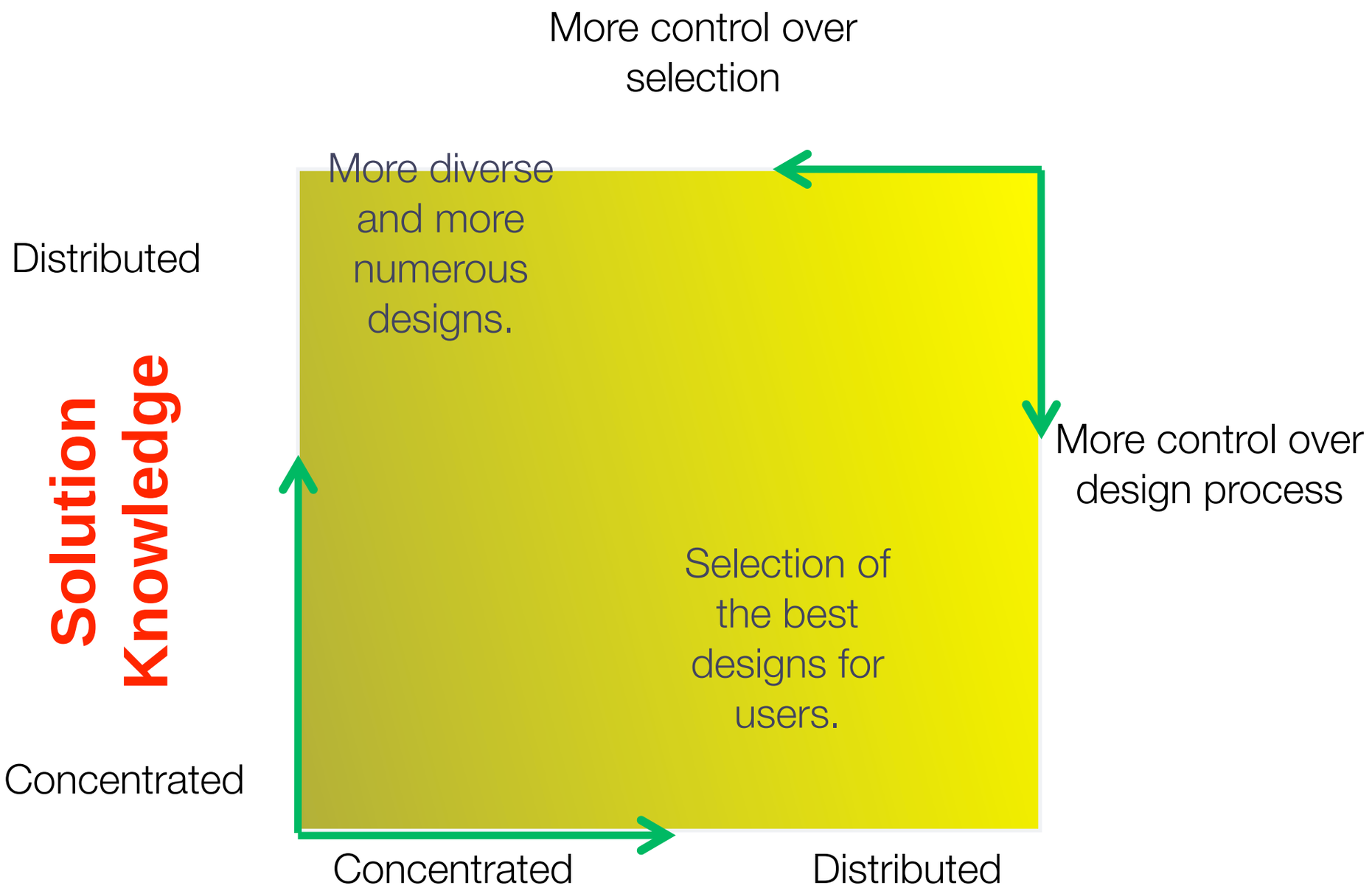


Back to the Innovation Funnel

Generation | Selection | Generation | Selection | **Implementation**



Locus of Innovation Generation and Selection Depends on Knowledge Boundaries



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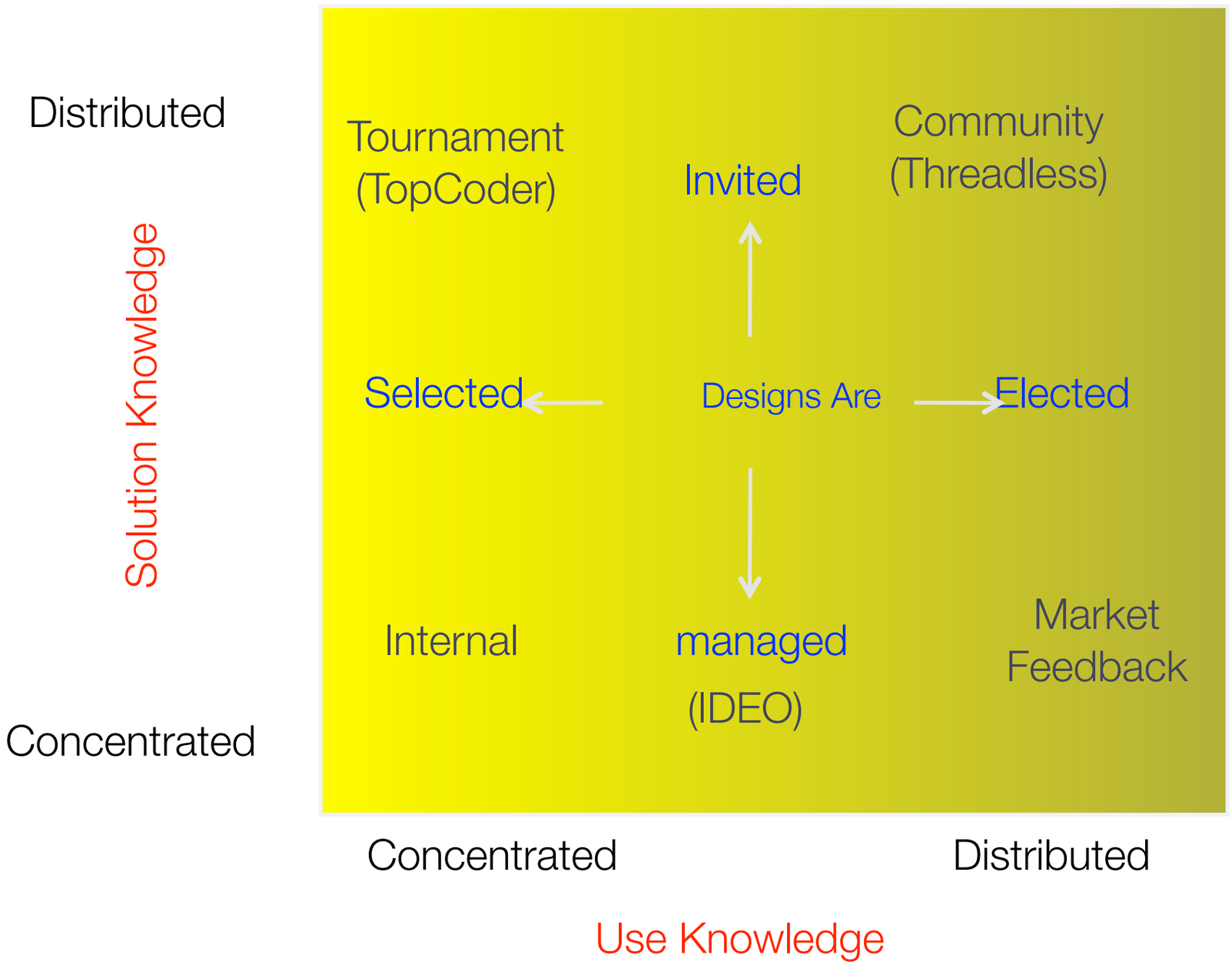


Questions Are Key!

- “The greatest challenge to any thinker is stating the problem in an way that will allow a solution” - Bertrand Russell

Key Issues

- Getting internal buy-in from organization (non-trivial!)
- Selecting/Designing problems for external solving
- Dealing with large volume of ideas
- Implementing solutions
- Making it systematic

WELCOME TO THE NASA TOURNAMENT LAB

Karim Lakhani (Harvard) & Jason Crusan (NASA)

NASA Tournament Lab

What is NASA Tournament Lab?

Operational Virtual Facility developed between NASA, Harvard, and TopCoder

Two Objectives -

1. Create novel, high quality working software for algorithmic / computational Challenges

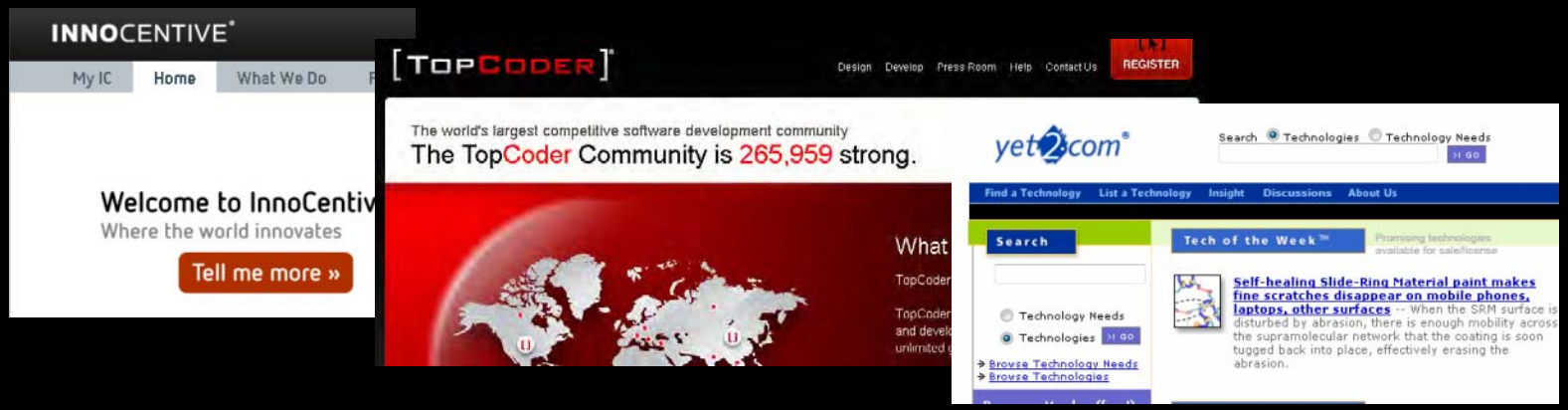
2. Contribute towards the development of empirically validated science of innovation tournaments

Utilize the principles of distributed innovation to allow participants worldwide to contribute to solving mission challenges by developing innovative computational algorithms.

NTL developed as an outcome of NASA Space Life Sciences Open Innovation Pilot Program (2009-2010)

Outcomes from the pilot lead NASA to consider software /algorithm challenges are different from other types of challenges

- Require different tools set for development of solutions
- Evaluation and Validation processes different
- Community management differences



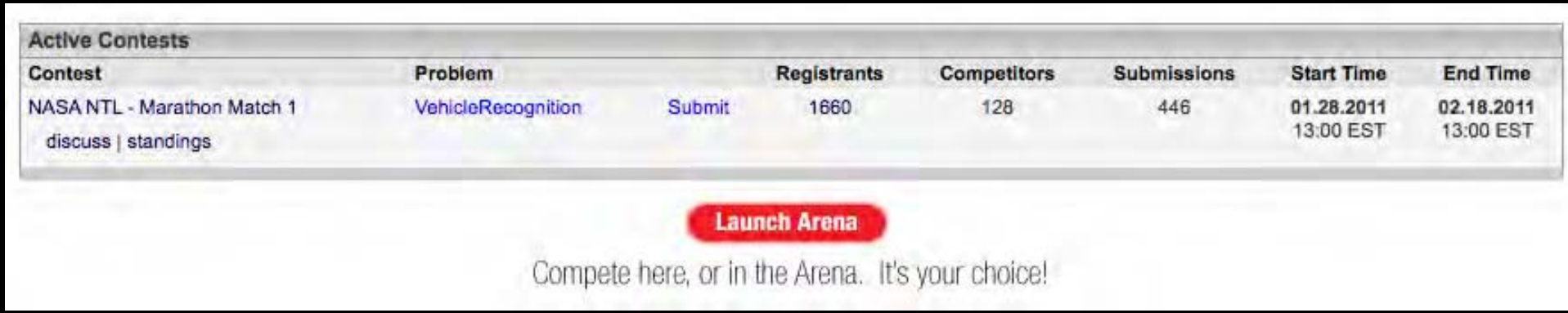

Sign-in to Portal
NASA Tournament Lab
powered by TopCoder
NASA Tournament Lab (NTL)
HOME
ABOUT
HOW TO COMPETE
NASA
FORUMS
RESEARCH PORTAL
WELCOME TO THE NASA TOURNAMENT LAB
NASA, Harvard Business School, and TopCoder have established the NASA Tournament Lab (NTL), which will enable the TopCoder community to compete amongst each other to create the most innovative, most efficient, and most optimized solutions for specific, real-world challenges being faced by NASA researchers.
read more
HOW TO COMPETE
Where to compete, how to register, and much more!
RESEARCH PORTAL
NASA researchers, sign in here!
Leaderboard
Handle Points
byronknoll 1
cannab 1
jagdish.vasani 1
parashurama 1
rado42 1
redquark 1
TheKingOfWrong 1
yowa 1
LATEST NEWS
JAN 28
The idea behind the first NTL marathon match challenge
posted by NASA_Terry on January 28, 2011 at 4:19 pm
The first NASA Tournament Lab challenge directly addresses NASA's on-going work to detect and classify features of scientific and humanitarian interest. NASA is interested in automatically processing remote sensing (aerial and satellite) data for a variety of reasons: there is increasingly too much data to deal with manually; there is a need to extract information from data in real-time; and there is an ever growing backlog of archived data waiting to be analyzed.
NASA has collected more scientific information about our planet and solar system than any entity in the history of humanity. The Mars Reconnaissance Orbiter alone
Active NTL Contests
NASA NTL - Marathon Match 1
$10000
More Details | Register | Discuss
News and Announcements
The idea behind the first NTL marathon match challenge
by NASA_Terry on 01/28/2011 (4:19 pm)
Welcome to the NTL
by mike on 01/26/2011 (7:18 pm)
View All

Current Status

Built out Portal on TopCoder Platform - Used Community to Build

- Graphic design (even sourced the logo using a challenge)
- Site layout and implementation

First Challenge Posted January 28, 2011 open until February 18, 2011



First Challenge

• Addresses NASA's on-going work to detect and classifiy features of scientific and humanitarian interest.
• NASA is interested in automatically processing remote sensing (aerial and satelite) data for a variety of reasons: there is increasingly too much data to deal with manually; there is a need to extract information from data in real-time; and there is an ever growing backlog of archived data waiting to be analyzed.
• NASA is developing computer-based techniques to automatically identify pre-defined features of interest in satellite imagery. This challenge will help NASA develop more robust feature detection algorithms to improve the triage and interpretation of planetary data.
• Additionally, NASA has worked with a broad range of federal agencies and non-governmental organizations to respond to and help mitigate a broad range of disasters. Each year, thousands of people die, millions of lives are disrupted and billions of dollars are spent coping with disasters. This challenge will help NASA to automatically detect and classify objects (e.g., stranded vehicles) in aerial images. This will enable disaster response to be faster and more efficient so that more lives can be saved.

NASA Tournament Lab

First Challenge








Example of Challenges in Formulation

- International Space Station - Solar Array Optimization
- International Space Station - Trajectory Optimization
- Planetary Data System - Open search APIs